



## Research paper

# Metacognition of daily self-regulation processes and personality traits in borderline personality disorder



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## ABSTRACT

**Background:** Patients with Borderline Personality Disorder (BPD) are characterized by impoverished self-regulatory mechanisms and self-image distortions. An intriguing question is to what extent BPD individuals develop accurate perceptions of their self-regulatory everyday functioning. Here, we tackle this issue evaluating their metacognitive abilities.

**Methods:** One hundred and forty-four participants were enrolled in the study and divided into a BPD group and a healthy Control group, with each consisting of 36 participants paired with their corresponding close relatives. We compared self-report evaluations of the participants' self-regulatory processes in daily-life activities and personality traits with external perceptions by close relatives, as a measure of metacognition. The ratings from participants and their informants were compared using an ANCOVA profile analysis.

**Results:** Self-report results showed poor self-regulation ability in the daily environment as well as extreme scores in personality-traits in the BPD group in comparison with healthy participants. Further, in the BPD group we found a clear discrepancy between the information provided by patients and their close relatives regarding the processes involved in self-regulation of daily-life activities (but not for personality traits). This discrepancy was related to their clinical status and was not observed in the healthy control group.

**Limitations:** Analysis was based on self-report data, focusing on the difference with informants reports only. Conclusions about the direction of a possible bias on participants' self-perception are limited.

**Conclusions:** Metacognitive deficits might play a key mediating role between the altered cognitive processes responsible for self-regulation and cognitive control and the daily-life consequences in BPD.

## 1. Introduction

A core aspect of Borderline Personality Disorder (BPD) is the lack of appropriate self-regulatory mechanisms (e.g. strong emotional dysregulation, behavior outbursts) most often manifesting in daily social contexts (King-Casas et al., 2008; Lieb et al., 2004). This aspect has been associated with deficits in both the ability to envision the mental states of others based on interpersonal cues, and in the use of social-feedback information to appropriately control their behavior (Bateman and Fonagy, 2004; Fonagy and Target, 2006). These social-

feedback signals are crucial for the correct construction of one's self-image (Diehl and Hay, 2007). Hence, it has also been reported that BPD patients show problems in self-image reconstruction, showing non-reflective, contradictory and chaotic descriptions of themselves (and others), a lack of awareness of their conflict appraisals (Kernberg, 1967) and problems in correctly processing emotional-related feedback (Vega et al., 2013). The hybrid model for the classification of personality disorders (section III, DSM-5) emphasizes alterations of self-functioning (mainly in identity and self-direction) as one of the main features of personality distortions, including BPD. Despite this interesting

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relationship between self-image processes and self-regulation mechanisms in real-life social situations, there is a lack of research on this topic in BPD patients.

Interestingly, cognitive neuroscience has recently paid much attention to the study of higher-order self-reflective cognitive processes that may be used to regulate information processing and to evaluate one's cognition and behavior (i.e. *metacognition*; Flavell, 1979). This metacognitive capacity is involved in monitoring (e.g. performance predictions) and controlling (e.g. error correction) multiple daily tasks (Nelson and Narens, 1994). Moreover, it involves mental representations of one's self-image (Lyons and Zelazo, 2011) and it is crucial for self-regulation learning (Ridley et al., 2011), self-confidence or self-efficacy perceptions (Kleitman and Stankov, 2007). A substantial body of research has implicated the prefrontal cortex (PFC) regions in metacognitive processing (Fernandez-Duque et al., 2000). Indeed, a decrease in metacognition (i.e. judgments of performance), without affecting task performance, has been observed when disrupting the dorsolateral PFC with transcranial magnetic stimulation (Rounis et al., 2010). Interestingly, performance on a cognitive task and metacognition of the performance are usually tightly coupled (i.e. metacognitive accuracy) and is also attuned to what others may observe (Nelson and Narens, 1994).

Broadly, dysfunctions in metacognition have been associated with a range of mental disorders (Barbato et al., 2014; Hezel and McNally, 2016; Olstad et al., 2015; Sun et al., 2017) including BPD (Outcalt et al., 2016). In addition, previous findings suggest alterations in the processing of self-related information in constructs such as self-esteem or self-concept in patients with BPD (Winter et al., 2017). However, there is a remarkable lack of studies that assess more specifically the processing of self-regulatory and cognitive control mechanisms in BPD. A better understanding of how these patients process this kind of information may be helpful not only to better understand BPD-psychopathology, but to also hamper successful treatment. Consistent with this line of research, previous findings suggest that psychological interventions based on metacognitive training may be effective in reducing BPD-symptoms (e.g. reducing negative self-view distortions in self-perception) and improving functionality (Jankowski and Holas, 2014; Schilling et al., 2018; Soler et al., 2012; see also: Wells and Matthews, 1996).

The aim of this study was to evaluate metacognitive abilities of a BPD sample in relation to self-regulatory and cognitive control mechanisms. We used a methodology that allowed us to measure self-regulatory processes in daily-life activities and to compare self-image evaluations with external perceptions of the patients' self-regulatory abilities by close relatives (paired informants; see for a similar methodology in adolescents with BPD-symptoms: Kalpakci et al., 2018). In addition, we contrasted these results on metacognition of self-regulation to the capacity of BPD patients to accurately estimate their long-lasting personality traits, based on previous studies which showed higher self- and informant-report concordance in BPD patients than in those with other personality disorders (Klonsky et al., 2002). This also allowed us to evaluate the generalization of these findings and to compare this to other domains in which patients need to correctly monitor autobiographical or self-referential memories. Finally, we assessed the extent to which metacognitive abilities would be related to functional and clinical BPD severity indexes.

In line with the above, three hypotheses were suggested. First, we hypothesized that the patients would show a poorer self-image of self-regulation abilities used in everyday functioning rather than healthy controls. Second, we hypothesized that, in the BPD group, we would observe a discrepancy between self- and close relatives' reports on self-regulation abilities, which may suggest that these patients exhibit a low metacognitive accuracy which involves a monitoring deficit in their self-regulation abilities used in everyday functioning. Third, we also predicted that this discrepancy would be associated with their clinical status, as it would be an ecological measure of their problems.

**Table 1**  
Demographical and clinical characteristics of participants (BPD and Control groups), and relevant data of informants.

Participant	BPD (n = 36)		Control (n = 36)		Analysis	
	Mean	SD	Mean	SD	t	p
Age (years)	32.03	7.15	29.17	6.05	1.83	0.072
Education (years)	15.75	3.07	18.66	1.26	-5.26	<0.001
IQ	96.86	9.78	98.05	8.54	-0.61	0.545
DIB-R	7.67	1.06				
GAF	50.22	8.41				
CGI-BDP	5.25	1.41				
HAM-D	10.91	4.49				
Medication Load	2.77	2.58				
N		%				
<i>Current comorbidity<sup>a</sup></i>						
Any Anxiety Disorder	11	30.6				
Eating Disorder	11	30.6				
Drug Abuse	10	27.8				
Other <sup>b</sup>	10	27.8				
<i>Past comorbidity</i>						
MDD	15	41.7				
Any Anxiety Disorder	7	19.4				
Eating disorder	7	19.4				
Drug abuse	12	33.3				
<i>Axis II comorbidity</i>						
Avoidant	5	13.9				
Dependent	9	25				
Obsessive-Compulsive	2	5.6				
Paranoid	4	11.1				
Eschizotypical	2	5.6				
Antisocial	6	16.7				
Informant	Mean	SD	Mean	SD	t	p
Years of relationship	20.89	12.84	18.06	10.01	1.04	0.301
N	%	N	%	$\chi^2$	p	
Sex (male)	16	44.4	22	61.1	2.01	0.157
Currently living together	23	63.9	19	52.8	0.91	0.339
Relationship						
Father/mother	12	33.3	9	25	1.47	0.479
Partner/spouse	12	33.3	17	47.2		
Other <sup>c</sup>	12	33.3	10	27.8		

<sup>a</sup> Comorbid disorders were assessed with SCID-I and SCID-II.

<sup>b</sup> This category includes, for example: adaptive disorder or distimic disorder.

<sup>c</sup> Includes other levels of relationship such for example sibling or cousin.

IQ=Intelligence Quotient; DIB-R= Diagnostic Interview for Borderlines Revised; GAF= Global Assessment of Functioning Scale; CGI-BPD=Clinical Global Impression-BPD; HAM-D=Hamilton Depression Rating Scale. MDD = Major Depressive Disorder.

## 2. Methods

### 2.1. Participants

Participants were recruited from the Borderline Personality outpatient treatment program of the Hospital of Igualada (Barcelona, Spain) and via a local advertisement for healthy volunteers. The study involved 144 participants divided in pairs of respondents (72 self-informing participants and their corresponding 72 informants consisting of close relatives). Of the self-informant participants, the sample consisted of 36 BPD and 36 healthy controls, all females and matched by age and intelligence (IQ; see Table 1). The BPD diagnosis was confirmed using the Structured Clinical Interview for DSM-IV Axis II (SCID-II) and the Diagnostic Interview for Borderlines-Revised (DIB-R; Barrachina et al., 2004). In addition, they were assessed with the SCID-I for DSM-IV.

The presence of brain injury, psychotic, bipolar or current major depressive disorders, drug abuse or an IQ below 80 were all exclusion criteria. Healthy participants had no historical or current mental disorders (they were also assessed with the SCID-I and SCIDII for the DSM-IV).

Informants were persons close to participants. They were parents (BPD = 33%, controls = 25%), partners/couples (BPD = 33%, controls = 47.2%), and other kind of relatives (including siblings, sons, cousins and uncles; BPD = 33%, controls = 27.8%). No difference between groups was found regarding the degree of kinship ( $\chi^2 = 1.47$ ,  $p = 0.479$ ). In addition, no difference was found between study groups in the duration of this relationship (number of years, reported by informants; BPD = 20.89 + 12.84; controls = 18.06 + 10.01;  $t = 1.04$ ,  $df = 70$ ,  $p = 0.301$ ).

All participants were informed about the purpose of the study. All procedures were approved by the local ethical committee and written informed consent was obtained from all participants.

## 2.2. Procedure

The assessment of participants was carried out in facilities at the Hospital of Igualada. Each self-informing participant answered the questionnaire about themselves and their close-relative informant separately answered the questionnaire about their corresponding self-informant. The informants gave their impressions of the target participant under confidentiality. In those cases where close-relatives were unable to attend, a packet with clearly written instructions about the procedure was provided to the self-informants to give to their paired informant. Researchers then contacted the informants (i.e. the close-relative) by telephone in order to verify that the instructions were understood and that they were followed correctly. Any questionnaires that did not meet the validity scales criteria were excluded ( $n = 8$ ; 11.11%).

## 2.3. Psychometric measures

The Behavior Rating Inventory of Executive Function-adult version (BRIEF-A; Roth et al., 2005) is a standardized 76 item self-report measure that captures an adult view of their own executive functions (EF), or self-regulation, in the daily environment. It consists of 9 clinical scales: inhibit (the ability to control impulses; ability to stop one's own behavior at the appropriate time), shift (the ability to move from one situation, activity, or aspect of a problem to another, as the circumstances demand), emotional control (to modulate mood appropriately), self-monitor (to attend to your own behavior in a social context), initiate (to begin a task or activity), working memory (to hold information in mind for the purpose of completing a task), plan/organize (to anticipate future events), task monitor (to check work and assess one's performance) and organization of materials (to keep workspaces and materials in a orderly manner). Higher scores indicate more executive dysfunction. T-scores of 65 or higher are considered clinically significant (Roth et al., 2005). The BRIEF-A also contains 3 validity scales: negativity, infrequency, inconsistency. Clinical scales form two subdomains: the Behavioral Regulation Index (BRI; first four scales) which represents the ability to self-regulate behaviors and emotions, and the Metacognition Index (MI; remaining five scales summarized) which represents the ability to self-regulate problem-solving and goals. The Global Executive Composite (GEC) is an overarching summary score that incorporates all the BRIEF-A clinical scales. The BRIEF-A has demonstrated good internal consistency, test-retest stability, and convergent and discriminant validity. In addition, both subdomains showed adequate internal consistency for patient (BRI:  $\alpha = 0.85$ ; MI:  $\alpha = 0.93$ ) and informants' reports (BRI:  $\alpha = 0.91$ ; MI:  $\alpha = 0.94$ ; Roth et al., 2005).

In a study of Ciszewski et al. (2014) in a clinical sample of adults with eating disorders, authors analyzed the construct validity of the BRIEF-A. They found a two-factor solution explaining 63.53% of the variance (similar to that reported in the BRIEF-A professional manual; Roth et al., 2005). Interestingly, these authors also reported a high positive and significant correlation between the GEC of the BRIEF-A patient-report and the GEC of the BRIEF-A informant-report ( $r = 0.849$ ,  $p < 0.01$ ).

In the present study, a significant discrepancy between self- and informants' reports was considered as a deficit in metacognitive monitoring on self-regulation abilities in the daily environment (i.e., executive functions). To that end, we focus on the 9 clinical scales and not in subdomains. Therefore, it should be noted that when we refer to metacognitive capacity thorough the manuscript, we are not referring to the 'Metacognitive Index' but the aforementioned discrepancy between ratings by the patients and informants.

The Five Factor Personality Inventory (FFPI; Rodríguez-Fornells et al., 2001) is a 100-item inventory which assesses the Big Five dimensional model of personality. It consists of five higher-order personality dimensions assessing extraversion (e.g. being assertive), agreeableness (e.g. being cooperative and tolerant), conscientiousness (e.g. being careful, responsible), emotional stability (e.g. anxiety, depression) and autonomy (e.g. the tendency to make independent decisions). The FFPI showed a good degree of construct validity with other well-known personality questionnaires. Besides, it has been shown that FFPI has a remarkably good and stable psychometric properties that generalize across cultures (Hendriks et al., 2003). The Spanish self-reported version shows good reliability coefficients for each dimension (extraversion:  $\alpha = 0.88$ ; agreeableness:  $\alpha = 0.84$ ; conscientiousness:  $\alpha = 0.86$ ; emotional stability:  $\alpha = 0.87$ ; autonomy:  $\alpha = 0.84$ ; Rodríguez-Fornells et al., 2001).

These two psychometric measures (BRIEF-A and FFPI) made up the self- and hetero- informing questionnaires.

## 2.4. Clinical severity measures

The Global Assessment of Functioning (GAF; APA, 2000) is a numeric scale (0 through 100) in which the clinician rates their impression about social, occupational and psychological functioning. Low scores indicate poor functioning.

The *Clinical Global Impression-BPD* (CGI-BPD; Perez et al., 2007) assesses the degree of severity in BPD patients. It contains 10 items that score the nine relevant psychopathological domains of BPD, as well as an additional global score.

The DIB-R (Barrachina et al., 2004) is a semi-structured interview used in the assessment of core symptoms of BPD and is divided into 4 areas: affect regulation, cognitive disturbance, impulsive behavior and interpersonal relationships. The assessment is focused on the last two years and the score ranges between 0 and 10, with 6 being the cut-off for diagnosing BPD.

## 2.5. Medication load

We computed a composite measure of total medication load used previously in psychiatric samples (Vederman et al., 2012; see supplementary materials for details).

## 2.6. Data analysis

Demographical, clinical and psychometric data were computed; for psychometric data, direct scores were converted to T-scores which were considered in the subsequent analysis. Differences between variables were evaluated using Pearson's Chi-square test ( $\chi^2$ ) for the categorical variables and a  $t$ -test (paired or independent) to compare mean values.

First, we studied the psychometric differences between informants (self- vs. relatives) using a pairwise  $t$ -test for each BRIEF-A clinical scale and FFPI dimension.

Second, we tested the differences between groups in self-reported information (Hypothesis 1) performing an independent  $t$ -test analysis (BPD versus healthy control participants) on BRIEF-A and FFPI; complementarily, we computed the frequency in which BPD self-reports were beyond the 65 T-score (i.e. mean plus one and a half standard deviation in a T distribution) in each BRIEF-A scale.

Third, we performed a repeated-measures ANCOVA (rmANCOVA)

introducing the psychometric profiles of the BRIEF-scales (inhibit, shift, emotional control, self-monitor, initiate, working memory, plan/organize, task monitor, organization of materials) with Informant (oneself versus relatives) as a within-subject factor and the Group (BPD patients and healthy comparison participants) as a between-subject factor (Hypothesis 2). If the Mauchly tests showed a violation of the sphericity assumption, Greenhouse-Geisser corrections were considered. The Medication load score was included as a covariate in all analyses to control for medication prescription variability. Additionally, given the differences between groups in education level (see Table 1), a complementary analysis including years of education as covariate was conducted (showing no significant effect; see Supplementary Information).

In accordance with our hypothesis, we focused this rmANCOVA profile analysis on three basic areas:

- 1 We expected a BRIEF-scales x Group interaction to show differences in the overall profile of EF between groups, independent of the informant (auto or hetero).
- 2 If there was a metacognitive deficit in BPD participants, we expected a Group x Informant interaction effect in the BRIEF-scales factor. This interaction would reflect that while no differences exist in the controls between self- and hetero- evaluations, a clear difference exists in BPD patients and is independent of BRIEF scales. Conversely, if the deficit is not consistent across the BRIEF-A profile and is only present in some subscales, a BRIEF-scales x Group x Informant interaction should be obtained
- 3 The same rmANCOVA analysis was carried out with long-term FFPI dimensions (extraversion, agreeableness, conscientiousness, emotional stability, autonomy).

Finally, a bivariate Pearson correlation analysis was carried out to analyze the relationship between BRIEF-A overall indexes (BRI and MI; Hypothesis 3), considering self- minus hetero- scores, and BPD severity measures (only *p*-values under 0.01 was reported). See also the Supplementary Information for additional analyses.

### 3. Results

#### 3.1. Clinical and demographical data

Clinical, demographical, and social characteristics collected from participants and their relatives are summarized in Table 1.

#### 3.2. Self-assessment on executive functions and personality (Hypothesis 1)

Self-reported mean T-scores on BRIEF-A clinical scales and FFPI dimensions are shown in Table 2. Firstly, results suggest that the BPD patients showed a lower self-view of their own daily EF and self-regulation capabilities (i.e. higher scores in all BRIEF-A clinical scales). Secondly, results suggest that the BPD patients rated themselves as less extraverted, agreeable, conscientious, emotionally stable and autonomous than the control participants (i.e. lower mean scores in FFPI personality dimensions).

Accordingly, the BPD participants also exceeded the 65 T-score at a higher percentage (range: 33.3–94.6, mean: 72.5, SD: 17.7) than the comparison group (range: 8.3–11.1, mean: 4.3, SD: 2.8) in all BRIEF-A clinical scales (see S1 for a detailed analysis). Hence, this supports the previous result of lower self-evaluation of EF in the BPD patients, relative to healthy participants.

#### 3.3. Profile analysis (Hypothesis 2)

The profile analysis is shown in Fig.1 (see also table S2). In accordance with our hypothesis, we found a significant interactive effect between BRIEF-scales and Group ( $F = 3.01$ ,  $df = 4.38$ ,  $p = 0.015$ ) and

FFPI-dimensions × Group ( $F = 10.39$ ,  $df = 4$ ,  $p < 0.001$ ). As expected, these simply showed that overall both BRIEF-A and FFPI profiles differed depending on the psychopathological condition (see Fig.1).

In addition, a significant interaction of Group × Informant ( $F = 23.64$ ,  $df = 1$ ,  $p < 0.001$ ) was encountered in the BRIEF-A analysis. This interaction reflects that while there were no differences between self- versus hetero- evaluations in the control group (see Fig.1), BPD patients consistently gave themselves worse ratings than their relatives did. This effect was consistent across the whole BRIEF-A profile (the interaction between BRIEF-scales × Group × Informant was not significant,  $F = 1.55$ ,  $df = 6.61$ ,  $p = 0.152$ ).

In the corresponding analysis for the FFPI, a marginal but significant interaction effect of Group × Informant ( $F = 4.21$ ,  $df = 1$ ,  $p = 0.044$ ) was observed, suggesting that self- and hetero- information was different in several FFPI-dimensions (the interaction between FFPI-dimensions × Group × Informant was also significant,  $F = 3.59$ ,  $df = 4$ ,  $p = 0.007$ ). Interestingly, healthy participants did not agree with their relatives in two dimensions (agreeableness and conscientiousness), whereas BPD participants differed only in one evaluation (emotional stability; see Table 2).

When the medication load was included as a covariate, it was not related to between-subject differences and interactive effects previously reported in both analyses (see Table S2).

#### 3.4. Self- versus Informant-assessment differences (Hypothesis 2)

As can be seen in Table 2, the pairwise *t*-test analysis revealed differences between self and hetero response information on all scales of the BRIEF-A measure in the BPD group and only in self-monitoring scales in the comparison group. Therefore, BPD patients rated themselves as less able than that of the evaluation performed on them by their relatives. In contrast, BPD patients showed similar scores to their informants in four of the five personality dimensions, with Emotional Stability being the only significant dimension in which BPD patients reported themselves as less stable. Interestingly, the control group showed no significant differences in personality for own vs. other's evaluation, except for agreeableness and conscientiousness.

#### 3.5. Relationship between BRIEF-A and clinical severity measures (Hypothesis 3)

Concerning the BRIEF-A overall indexes (see Fig.2), we found that the difference between self- and informant- reports (i.e. metacognitive accuracy) on BRI was associated with the DIB-R cognitive area ( $r = 0.47$ ,  $p < 0.01$ ). Thus, poorer metacognitive accuracy in BRI index (i.e. the ability to maintain appropriate regulatory control of behavior and emotional responses) was associated with a higher presence of strange, suspicious and paranoid thoughts. Differences in MI were associated with the CGI Paranoid dimension ( $r = 0.45$ ,  $p = 0.01$ ), suggesting that poorer metacognitive accuracy in the MI index (i.e. the ability to cognitively manage attention and problem solving) was associated with most paranoid symptoms.

We found no significant correlations with other clinical or functional measures (e.g. GAF).

### 4. Discussion

The present study investigated the metacognitive abilities of a BPD sample (and a matched control group) in relation to their self-regulatory and cognitive control capacities. We analyzed these processes in daily-life activities by means of a comparison between self-image evaluations vs. external perception by their close relatives. Importantly, current results suggest that BPD patients show a potential bias in the metacognitive evaluation of their self-regulatory capacity, which does not generalize to other self-image domains (long-lasting personality traits). In addition, these is the first empirical data on executive



**Table 2**  
Descriptive statistics of psychometric measures divided into information source and group.

Variable	BPD ( <i>n</i> = 72)					CONTROL ( <i>n</i> = 72)					
	Self		Informant		Self vs. Informant	Self		Informant		Self vs. Informant	Self-BPD vs. Self-Control
	Mean	SD	Mean	SD	<i>t</i> -test	Mean	SD	Mean	SD	<i>t</i> -test	<i>t</i> -test
<b>BRIEF</b>											
Inhibit	69.75	11.85	61.15	9.39	5.45 ***	45.32	7.11	46.04	6.06	−0.74	10.61 ***
Shift	75.98	10.05	67.18	8.32	5.22 ***	50.01	9.34	50.63	8.83	−0.47	11.35 ***
Emotional Control	76.35	6.66	66.89	7.69	7.48 ***	50.45	8.68	50.28	6.76	0.13	14.21 ***
Self.Monitor	72.15	10.85	63.42	10.19	4.45 ***	49.33	11.13	46.28	7.48	2.59 *	8.80 ***
Initiate	74.57	12.06	65.09	11.16	5.29 ***	47.46	8.85	48.31	7.96	−0.78	10.87 ***
Working Memory	73.46	13.11	60.91	10.77	6.23 ***	44.68	7.19	45.05	6.41	−0.25	11.55 ***
Plan/Organize	71.51	9.06	60.96	7.81	7.05 ***	49.75	6.96	47.52	6.55	1.85	11.41 ***
Task Monitoring	69.55	10.61	61.72	9.25	4.47 ***	47.89	8.95	47.97	7.69	−0.06	9.36 ***
Org. Materials	58.84	11.56	53.48	10.08	3.13 **	46.54	8.26	46.66	8.38	−0.11	5.19 ***
BRI	79.54	8.51	66.87	7.77	10.01 ***	50.21	9.04	48.31	6.47	1.76	14.16 ***
MI	72.68	10.81	61.39	8.35	7.85 ***	47.17	7.36	46.71	6.68	0.43	11.71 ***
<b>FFPI</b>											
Extraversion	43.16	11.30	44.01	10.79	−0.42	53.27	8.12	54.36	8.77	−1.09	−4.35 ***
Agreeableness	45.58	11.46	40.63	13.95	1.72	54.94	7.02	50.63	9.54	2.91 **	−4.17 ***
Conscientiousness	42.01	10.62	41.25	11.93	0.33	55.83	8.24	59.01	8.28	−2.96 *	−6.17 ***
Emotional Stability	33.51	8.99	39.27	10.31	−2.73 *	56.58	7.01	55.97	6.91	0.53	−12.14 ***
Autonomy	45.38	12.12	46.41	10.97	−0.38	50.16	7.54	48.94	7.78	0.81	−2.01 *

The data depict mean T scores for the BRIEF-A clinical scales and overall indexes, Behavioral Rating Index (BRI) and Metacognition Index (MI), as well as for the FFPI personality dimensions. The Student's *t*-test is presented for self- and informant-reports comparisons for each group as well as for self-reports comparisons. The data shows that the differences between informants were statistically significant for BRIEF-A only in the BPD group but not in the Control one and, for the FFPI, this difference is centered in FFPI-Emotional Stability scale for the BPD group and in Agreeableness and Conscientiousness dimensions for the Comparison group. Concerning self-reports the *t*-test analysis shows statistical differences between groups both for BRIEF-A and FFPI. \*  $p < 0.05$ ; \*\*  $p < 0.01$ ; \*\*\*  $p < 0.001$ .

functions (EF) evaluated using the BRIEF-A in a well characterized BPD sample of adults.

Importantly, metacognitive deficits may involve an inability to monitor (or be aware of) one's own symptoms and a diminished capacity to accurately self-appraise behaviors (Schmitz et al., 2006). This (in)capacity has been linked with PFC areas (mainly ventromedial, rostralateral, dorsolateral and cingulate regions) and, usually, patients with damage in these brain regions show a discrepancy between their self-perception and their current level of functioning (they underestimate their functional limitations; Schmitz and Johnson, 2007). Interestingly, the results of the current study show that BPD participants potentially showed worse self-appraisal (i.e. profile analysis) than that of their relatives in the BRIEF-A assessment. This may suggest that, while healthy participants properly monitor their daily executive functioning, BPD patients show a lesser ability to do so.

However, caution is needed when interpreting the present findings because the reverse is also possible, in the sense that relatives could also be underestimating functional limitations of patients. Since relatives are people very close to the patient, their point of view may be consciously or unconsciously biased, showing a tendency to judge their loved one less negatively. These biases could be based on imperfect sampling of patient's behavior (especially in this case real-world' daily activities) and therefore they might reflect the inference of inaccurate beliefs that create a more positive view of overall patient's mental health. This might be possible even considering that relatives gave their impressions of the target participant under confidentiality, which might favor the idea that they respond honestly in order to be helpful. Indeed, the lack of discrepancy in most of the FFPI-traits supports the idea that assessments were quite accurate. Besides, the absence of any discrepancy in the healthy control group is also consistent with this interpretation, suggesting a lack of tendency to judge loved ones less negatively in the current study. However, further studies will need to address this important limitation of the present study.

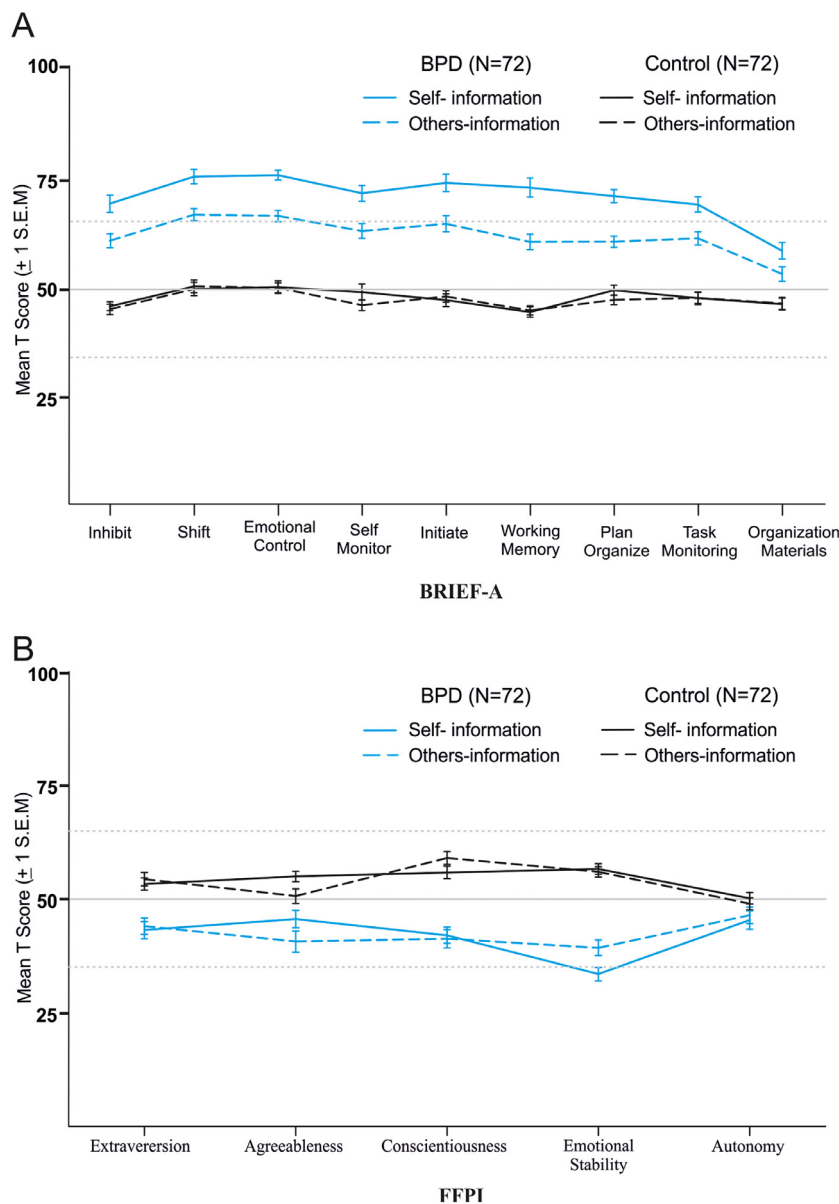
Importantly, differences observed in metacognition were selective for cognitive control and self-regulation mechanisms but not for most of

the personality dimensions evaluated (FFPI). Indeed, the only personality trait which showed significant differences in accuracy was emotional stability, with patients viewing themselves as less stable than their informants did. This finding is in line with previous results using personality measures (Klonsky et al., 2002; see also: Oltmanns et al., 2005; Oltmanns and Turkheimer, 2002). Moreover, this result is consistent with findings that suggest feedback processing alterations in BPD patients (Vega et al., 2013), which has been associated with self-regulation problems and increased difficulties in adapting their behavior based on previous experiences. This alteration may result from a reduced capacity to properly monitor relevant external information (see for a review on this topic: Northoff and Hayes, 2011).

The present results tend to suggest that metacognitive abilities could play a key mediating role between the altered cognitive processes responsible for self-regulation and cognitive control (not always captured by traditional laboratory-based tasks: Hagenhoff et al., 2013; see for a review: Paret et al., 2017) and the daily-life consequences in these patients.

Thus first, even when these problems were present and were easily observable by their close relatives, BPD patients' showed differences in their monitoring system. One possibility is that this self-image bias on their own functioning might affect self-efficacy (Akama, 2006), which is in accordance with previous studies showing reduced self-confidence in these patients (Koenigsberg et al., 2010). People who are low in self-efficacy are easily discouraged by challenges and failures, tend to not apply appropriate self-regulatory goals, and they also experience frequent emotional disturbances (Clark and Beck, 2010; Nelson and Narens, 1994), as is often observed in BPD patients (Skodol et al., 2002). Indeed, they often have maladaptive behaviors such as non-suicidal self-injury acts for self-regulating their stress emotions (Glenn and Klonsky, 2009).

Second and most importantly, poor metacognitive skills not only involve difficulties in monitoring suitable strategies for different tasks but also the conditions under which these strategies might be used and in the knowledge of the extent to which these strategies are effective



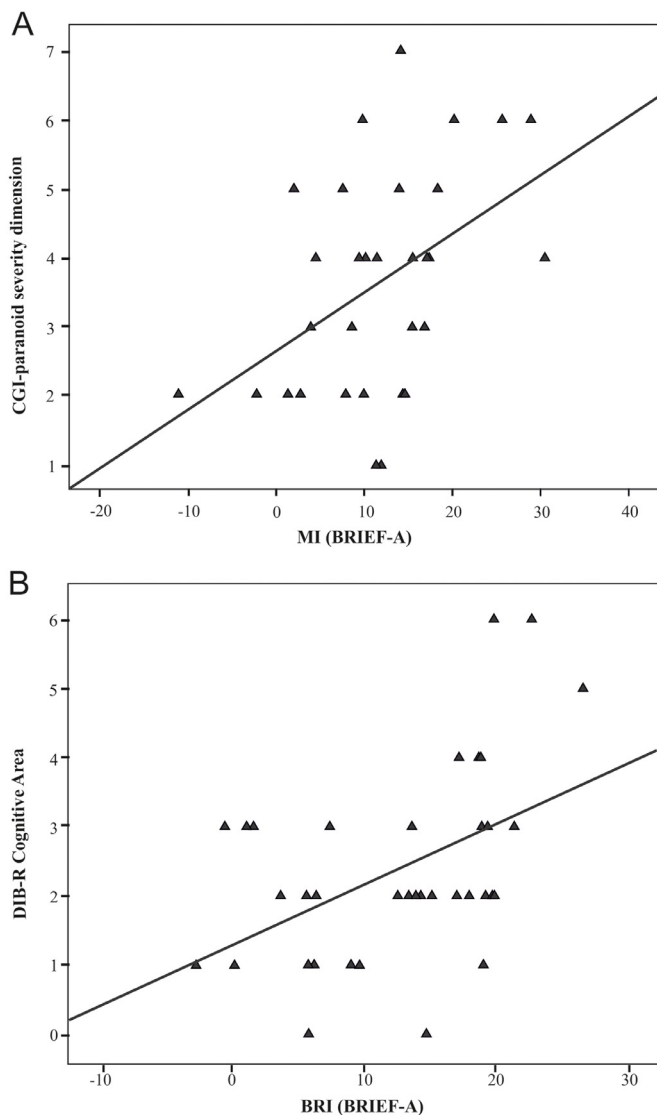
**Fig. 1.** BRIEF-A and FFPI profiles for BPD and Control groups. The figure shows T mean scores of the information provided by each participant (self-information) and by their corresponding informants (others-information). The dotted line shows the  $\pm 1$  SD of the mean (65 and 35 T-scores), indicating the limits of the normal T distribution. Panel A shows the data from BRIEF-A of BPD patients and control participants, and corresponding to their informants. In the panel B is shown the data obtained in the FFPI.

(Flavell, 1979; Pintrich, 2002). Therefore, in BPD patients it seems plausible that these overestimation judgments result in difficulties in their capacity to correctly plan and learn in a flexible manner, as well as in their ability to voluntarily re-appraise aversive stimuli (see for example: Schuermann et al., 2011; Schulze et al., 2011).

Finally, the notion of a metacognitive problem in these patients is reinforced by the greater effectiveness of psychological treatments rather than psychopharmacological ones (Stoffers et al., 2012). Thus, some of these treatments are designed to improve BPD patients' clinical status by means of enhancing the capacity to monitor daily-life activities. For instance, mindfulness training, an active component of dialectical behavioral therapy (Linehan, 1993) promotes the awareness of all emotional and cognitive events as they occur in the present, promoting a shift in mental processes rather than a direct change of the mental contents or behaviors (Chiesa et al., 2013).

Importantly, we also observed a clear relationship between metacognitive deficits (considering both overall indexes of the BRIEF-A) and

clinical status in the BPD group. Low metacognitive accuracy (higher self- vs. informant- discrepancy) in BRI and MI indexes was associated with a higher presence of strange, suspicious and paranoid thoughts (but not psychotic, showing higher scores in DIB-R cognitive area and in CGI-paranoid scale). Transient stress-related paranoid ideation is one of the diagnostic criteria for BPD. Importantly, this finding suggests that metacognitive problems observed in BPD participants could, at least partially, be related to biases in social feedback processing (a core aspect of the disorder; see: Roepke et al., 2012) and difficulties with integrating this kind of information for appropriate self-regulation, monitoring, and cognitive control. This finding is also consistent with studies suggesting a role of negative metacognitive beliefs about the management of unwanted thoughts and delusional and/or paranoid ideation in both clinical (Morrison and Wells, 2003) and non-clinical populations (Laroi and Van der Linden, 2005), showing a difference between the ideation (perceiving an interpersonal threat) and a self-regulatory mechanism that maintains it (metacognitive in nature;



**Fig. 2.** Correlation between BRIEF-A overall indexes (BRI and MI) and clinical measures. The BRIEF-A overall indexes were computed based on the difference between self- and informant-reports. In panel A, scatterplot depicts the correlation between BRIEF-A MI index and CGI-paranoid severity dimension ( $R^2 = 0.206$ ). In panel B scatterplot depicts the correlation between BRIEF-A BRI index and DIB-R cognitive area ( $R^2 = 0.221$ ).

Chadwick, 2014; Morrison et al., 2011; Murphy et al., 2017).

Furthermore, our findings provide support for the idea that a discrepancy between patients' and relatives' reports are ecologically valid reflections of their daily problems, which is in line with previous research. For instance, Castine et al. (2019) used discrepancies in self versus informant report (in the frontal systems behavior scale, FrSBe) as a measure of self-awareness, with higher scores representing an underestimation of behavioral symptoms. Interestingly, these authors reported that poorer self-awareness of disinhibition deficits (e.g., impulsivity, affective instability) is negatively associated with ability to maintain motivation during treatment.

Previous neuropsychological studies using traditional tasks, have not agreed on EF alterations in BPD patients (Hagenhoff et al., 2013). Here, we use a more ecological measure, the BRIEF-A, and we found alterations in a wide range (all scales) of EF involved in 'real-world' daily activities, which fits well with self-regulation and cognitive control problems in these patients (Skodol et al., 2002). This result is consistent with previous findings suggesting a relationship between

poor daily performance (using the BRIEF-A) and externalizing BPD-symptoms in adolescents (Kalpakci et al., 2018) and suicide (Saffer and Klonsky, 2017). Importantly, further studies might be interested in conducting research using more ecological evaluations of EF involved in 'real-world' daily activities (e.g., using Ecological Momentary assessments; Shiffman et al., 2008) and in order to validate the conclusions of the present research.

#### 4.1. Limitations

The findings of the study should be evaluated considering some limitations. First, the sample size was small, and all participants were females. Second, the study was based on self-reports and did not include a gold standard measure of EF (such as a behavioral measure or a third evaluation provided by a clinician). Third, we used a correlational analysis which cannot prove cause-and-effect relationship between metacognition (i.e. the discrepancy between self and relatives) and the clinical status in the BPD group. Finally, the comparison of BPD individuals with ostensibly healthy/normal individuals, although informative to some extent, leaves open the specificity of our findings to BPD per se as opposed to other personality disorders or even pervasive emotional maladjustment in general.

#### 5. Conclusions

The results of the present study provide early support of impaired metacognitive capacity on self-regulation processes involved in daily functioning in patients with BPD. In addition, it constitutes the first BRIEF-A data gathered on these patients.

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#### CRedit authorship contribution statement

**Daniel Vega:** Writing - original draft, Conceptualization, Project administration, Validation, Writing - review & editing. **Rafael Torrubia:** Conceptualization, Writing - review & editing. **Josep Marco-Pallarés:** Conceptualization, Writing - review & editing. **Angel Soto:** Project administration, Writing - review & editing. **Antoni Rodriguez-Fornells:** Writing - original draft, Conceptualization, Writing - review & editing.

#### Declaration of Competing Interest

None.

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None.

#### Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.jad.2020.02.033](https://doi.org/10.1016/j.jad.2020.02.033).

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